**Response to the University of Chicago Review of Materials Science Division**
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The Materials Science Division thanks the University of Chicago and the Review Panel for organizing a highly effective review of our programs and strategies. The Panel consisted of top scientists in the fields of materials science, condensed matter physics, and materials chemistry. They carried out a thorough review and their report provides a thoughtful analysis of our present status and future directions.

The Review Panel made observations and recommendations on (1) MSD's long range plan and strategy for implementing new scientific programs, (2) barriers to synergistic interaction of science and facilities, (3) coordination of hiring, program development, and program management across MSD, CHM and CNM, (4) the balance between basic science and applications in MSD programs, and (5) mentoring of early career staff.

*MSD's long-range plan and strategy for implementing new scientific programs*
"The MSD, although not having a detailed long-range plan, has a well-defined, and demonstrably effective, strategy for identifying and supporting strategic opportunities for high impact programs and should thus be able to sustain its vigorous contributions. The committee recommends that this strategy be made available to all of the staff."

Following the announcement at the end of February of plans to double the Office of Science budget over the next ten years, the authors of this response crafted an outline of a five-year strategic plan coupling likely opportunities for program growth to MSD's core scientific strengths, to basic science programs in partner divisions like Chemistry and the Center for Nanoscale Materials (CNM), and to the materials research user facilities in the Electron Microscopy Center, the Intense Pulsed Neutron Source, the Advanced Photon Source, and CNM. The outline is similar to the one presented to the Review Panel and it identifies six areas with potential for high impact research:

*Science and materials for energy,* addressing the demand for doubling energy production by 2050 without deleterious effect on the environment (e.g. catalysis, biological and bio-inspired energy conversion, basic research supporting hydrogen as an energy carrier, sunlight as an energy source, high performance superconductors, nuclear energy, and energy storage).

*Scattering science with electrons, neutrons and x-rays,* designed to advance the frontiers of materials science and develop new scientific capability for BES scattering facilities (e.g., Transmission Electron Aberration Corrected Microscopy (TEAM), single crystal diffuse scattering, and spin echo resolved grazing incidence spectroscopy (SERGIS)).

*In situ experiments,* designed to probe the real-time dynamics of physical, chemical, and biological phenomena (e.g., MOCVD epitaxial film growth and environmental TEM).

*Grand challenges of fundamental science,* which will advance our basic understanding of the behavior of materials (e.g., the mechanism of high temperature superconductivity, catalysis, and molecular control of chemical transformations).

*Emerging science frontiers,* to explore opportunities for discovery of new fundamental phenomena (e.g., biomolecular materials, quantum computing, plasmonics, spintronics, complexity, etc.)

*Applications of MSD basic research,* to translate MSD's discovery science to materials development (e.g., ultrananocrystalline diamond films, hydrogen sensors, artificial retinas, high temperature superconducting wires).

Action: We will engage MSD staff in the planning process and post the outcomes on our internal web site.

*Barriers to synergistic interaction of science and facilities*

"A long tradition of the Division and Argonne National Laboratory is that 'science drives facilities and facilities drive science.' The committee is concerned that recent organizational changes in DOE have put this paradigm at risk in some cases. In particular, the separation of facilities from science in DOE management has introduced barriers between science and facilities, which were not present in the recent past. The panel recommends that special care be taken by the management to ensure the synergistic interaction between science and facilities continues at the laboratory."

The Review Panel points out growing barriers to further development of one of the Laboratory's traditional strengths: intimate linking of forefront scientific programs to user facilities. These barriers apply not only to MSD's frontier science programs, but also to those of other science divisions at Argonne. The barriers arise from the separate management of science programs and user facilities extending from Argonne through all levels of BES, the different metrics and review procedures that are applied to science and facilities programs, and the weak incentives for science programs to invest in developing next-generation instrumentation for facilities.

Action: Addressing the growing barriers to "science driving facilities, facilities driving science" requires initiative across the science-facilities interface within Argonne. MSD will convene regular meetings of its Division Director and members of its staff with their counterparts in the Facilities ALDship. These meetings will serve to highlight barriers and opportunities to overcome them at the Divisional level. Effective action may require procedural and policy changes in the relationship of science to facilities that can be achieved only at the Laboratory Directorate level.

*Coordination of hiring, program development, and program management across MSD, CHM and CNM*

"In the matter of the Center for Nanoscale Materials (CNM), the committee is concerned that there be coordination of hiring and program development in areas of nanoscience, between Chemistry, MSD and CNM. Regular consultation at the directors' level could ensure such coordination. In addition it is important that there be no barriers to joint projects, and that there be plans for managing joint projects."

The ramp-up of CNM in FY07 represents a strategic opportunity for the Laboratory to build outstanding programs in interdisciplinary nanoscience spanning chemistry, materials, and biology. Such programs require a critical mass of people, ideas, and techniques that integrate synthesis, characterization, theory, and simulation. Although such programs can be built within a single division, the natural and more powerful approach is to create interdisciplinary teams drawing resources and developing capabilities across MSD, CHM, and CNM. The intense program building required for CNM's ramp-up and the program growth in MSD, CHM, and CNM enabled by the projected doubling of the Office of Science's budget over the next decade offer historic opportunities to build enduring science programs of the highest caliber. Taking advantage of this opportunity requires strong coordination of hiring, program development, and program management across the intellectual resource base of MSD, CHM and CNM.

Action: Effective coordination of hiring, program development, and program management across MSD, CHM and CNM suggests the need for a forum in which the Division Directors and members of the senior staff of MSD, CHM and CNM can identify strategic directions that span the capabilities of the three divisions, discuss coordinated hiring and program development, manage and review joint programs, and develop joint funding proposals to BES and other funding sources. Our new AD endorses this approach and has begun meeting with the 3 DDs.

*Balance between basic science and applications in MSD programs*

"Although a basic science enterprise, recently there has been a spin-off company formed to exploit ultrananocrystalline diamond technology developed in the Division. This appears to be a successful approach and we encourage MSD to continue to enable their staff to pursue applications-driven research according to their interests. The panel recommends that the Division attempt to enhance the impact of its science on industry by conducting industrial outreach. It feels that open communication of scientific advances to an industrial audience is extremely valuable. It does not recommend a focus on the control of intellectual property."

MSD is broadening its horizons to identify, disclose, patent, and market its intellectual property. We will seek additional opportunities to pursue applications-driven research especially where it synergistically reinforces our discovery programs. These could provide opportunities for funding outside BES and for interaction and collaboration with the industrial research community. Enlightened interactions with industry can extend the impact of MSD's discovery science and identify new materials programs that build on MSD's core strengths.

Action: We intend to encourage application programs where there is synergy with our discovery science programs. Staff members who see such opportunities will be encouraged to pursue them. MSD will enhance its outreach to industry by hosting visits of selected companies to present our research activities and to explore opportunities for cooperation. Outreach to the information technology industry and to the energy sector is especially promising for cooperative development of some of MSD's strategic interests.

*Mentoring of early career staff*

"A key to many of the new initiatives of the Division is the success of junior staff working in interdisciplinary or cross-disciplinary areas. Mentoring and career guidance of junior staff by senior staff is particularly important to ensure the success of these activities. The committee recommends that each junior staff member receive adequate mentoring by his/her manager or another senior staff member."

Action: MSD fully agrees with the Review Panel's view that mentoring of early career staff is key to the Division's future success. We will institute a new mentoring program where each early career staff member is assigned two senior mentors whose task is to advance the scientific and professional career of their protégé. The mentoring program will include arranging invited talks at professional meetings and research institutions, coaching in giving talks and writing proposals for internal and external funding, building communication skills, writing nominations for awards, and building strong records of scientific and professional achievement. Mentors will be encouraged to learn mentoring techniques through formal and informal instruction and to sharpen their skills through shared experiences. Mentoring is also part of each senior staff member's annual evaluation.